Space Weather Technical Forecast

Issued on Sunday, 17 July 2022 at 13:05 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1-R2 Likely at first, risk reducing later. Chance of G1 Days 3-4 (19-20 July) with CME arrival. Active electron fluence likely continuing until CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24 hours, with an M1.4 flare from AR3055 at 16/1539UTC. There are currently eight active regions on the solar disc at present, with the most complex being AR3058 in the northwest which contains a delta configuration in one of its spots. There was little change in most sunspot regions in this period, although AR3053 produced a long period C-flare, which suggests it may be more complex than we can see due to the viewing angle near the limb.
A large filament lifted off from the northwestern quadrant and largely erupted heading north and west of the Sun-Earth line between 13/1300 and 1600UTC. This was clearly visible as a partial halo in resulting Lasco imagery, with good triangulation available from STEREO A COR2. The most likely arrival time for this feature is either late on 19 July or early on 20 July. Another large filament that lifted from the southwest quadrant later in the day of 16 July is unlikely to have a significant Earth-directed component, although modelling is still ongoing. No other Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by ACE at L1, has been slightly elevated over the past 24 hours, likely from a waning high speed stream, possibly from CH99/+. The speed was mostly slightly elevated, mainly varying between 370-500 km/s. The density was mostly average or below average. The IMF was weak at 7nT or below, with the north-south component varying between +4/-3 nT. The phi angle was positive (away from the Sun) throughout. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, was at Background levels.
The high energy electron flux (greater than 2 MeV) has been High throughout with a peak of 3580pfu at 17/1135UTC. The 24-hour integrated electron fluence exceeded the Active (1e8 integrated pfu) threshold during the UTC evening of 16 July with a rising trend and an observed value at 17/0000UTC of 1.37e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to be Moderate, with a daily Slight Chance of X-class flares. Two of the current large sunspots should leave the Earth-facing side into the new week, resulting in a slight reduction in flare probability. Arriving bright flux over the eastern limb may compensate for any loss, however.

Solar Wind / Geomagnetic Activity: The 15/1300UTC filament CME is due to impact Earth either late on 19 July or early on 20 July. Slightly elevated solar wind speeds should continue to decline through Day 1 (17 July). Some minor influence from CH03/- is expected on day three

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(Tuesday 19 July), but it is expected to be a minor player given the CME due around the same time.
Geomagnetic activity is likely to remain at Quiet levels through Days 1 and 2, but becoming Unsettled to Active (probably protracted) with a Chance of G1 on 19 July from the combined effect of the CME mentioned above, and any high speed stream from CH03. The slow speed of the assessed CME may result in the risk of G1 extending through midweek UTC before easing.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is likely to remain at Background levels, but with a daily Slight Chance of S1 or greater due to the presence of large sunspot regions in the west or near centre-disc.
The high energy electron flux (greater than 2 MeV) is expected to remain at High levels until Days 3 or 4 (19-20 July) when a CME is due to arrive and suppress flux levels. Fluence levels are above the Active (1e8 integrated pfu) threshold and likely to remain so, perhaps with a downward trend, until the CME arrives when a sharp drop should occur.

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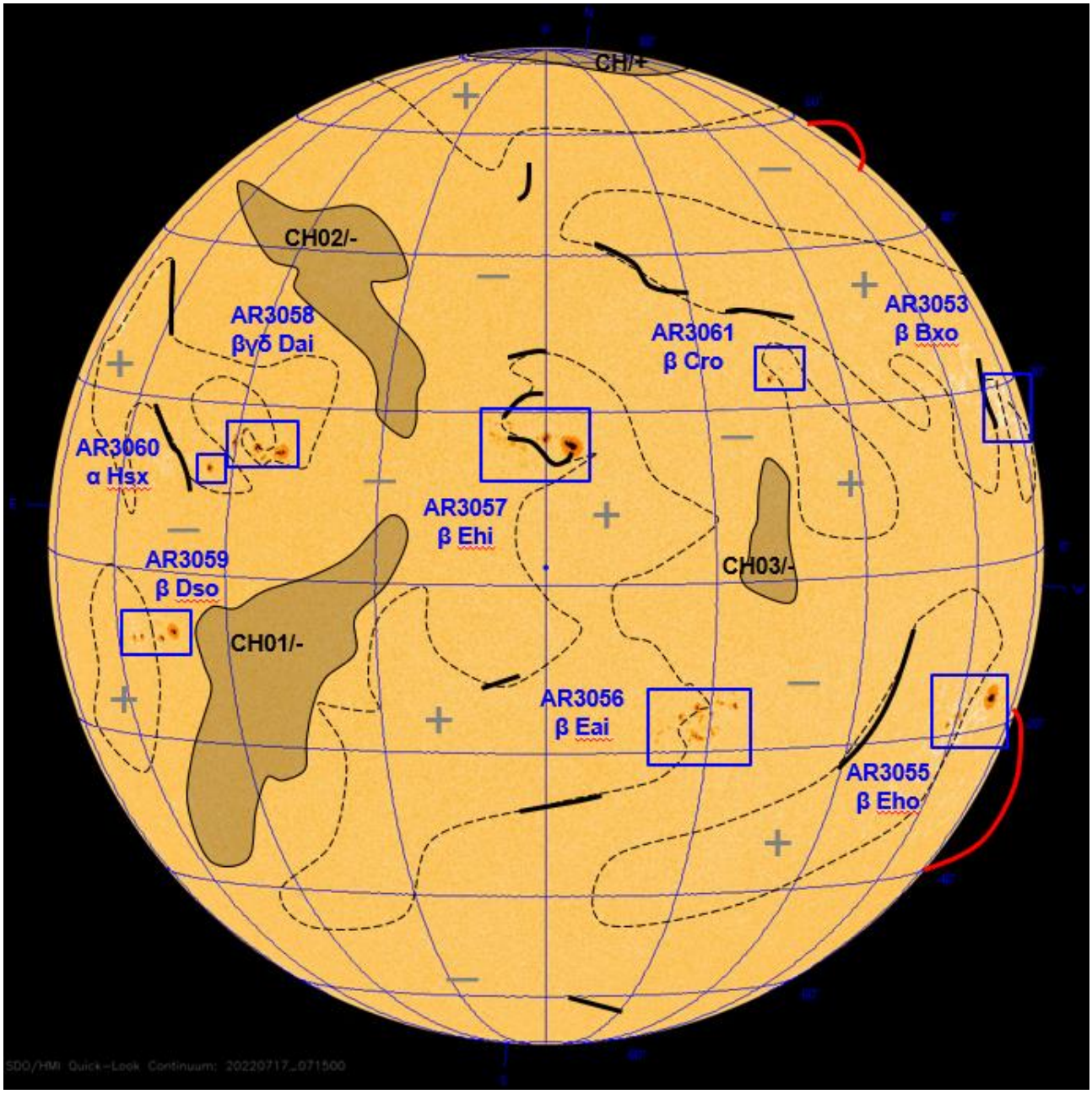
Figure 1. Solar Analysis Valid 17/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The 15/1300UTC filament CME is due to impact Earth around the turn of the UTC day Tuesday 19 into Wednesday 20 July. Another large filament that lifted from the southwest quadrant later in the day of 16 July is unlikely to have a significant Earth-directed component, although modelling is still ongoing. No other CMEs feature. Solar wind speeds are now slightly elevated as HSS effects wane and should continue to decline through Day 1 (17 July). Some minor influence from CH03/- is expected on day three (Tuesday 19 July). This CH is relatively ill-defined on the current disc, but its appearance is a reasonable analogue with last pass and it is expected to be a minor player given the CME due around the same time.

Geomagnetic activity is likely to remain at Quiet levels through Days 1 and 2, but becoming Unsettled to Active (probably protracted) with a Chance of G1 on Tuesday 19 July from the combined effect of the 15 July CME mentioned above, and any high speed stream from CH03. The slow speed of the assessed CME may result in the risk of G1 extending through midweek UTC before easing.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	40	40
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0209	Partial	Filament eruption	NW quadrant	395 km/s	19/2359 UTC, +/- 9 hours	Partial halo with main ejecta ahead of Earth

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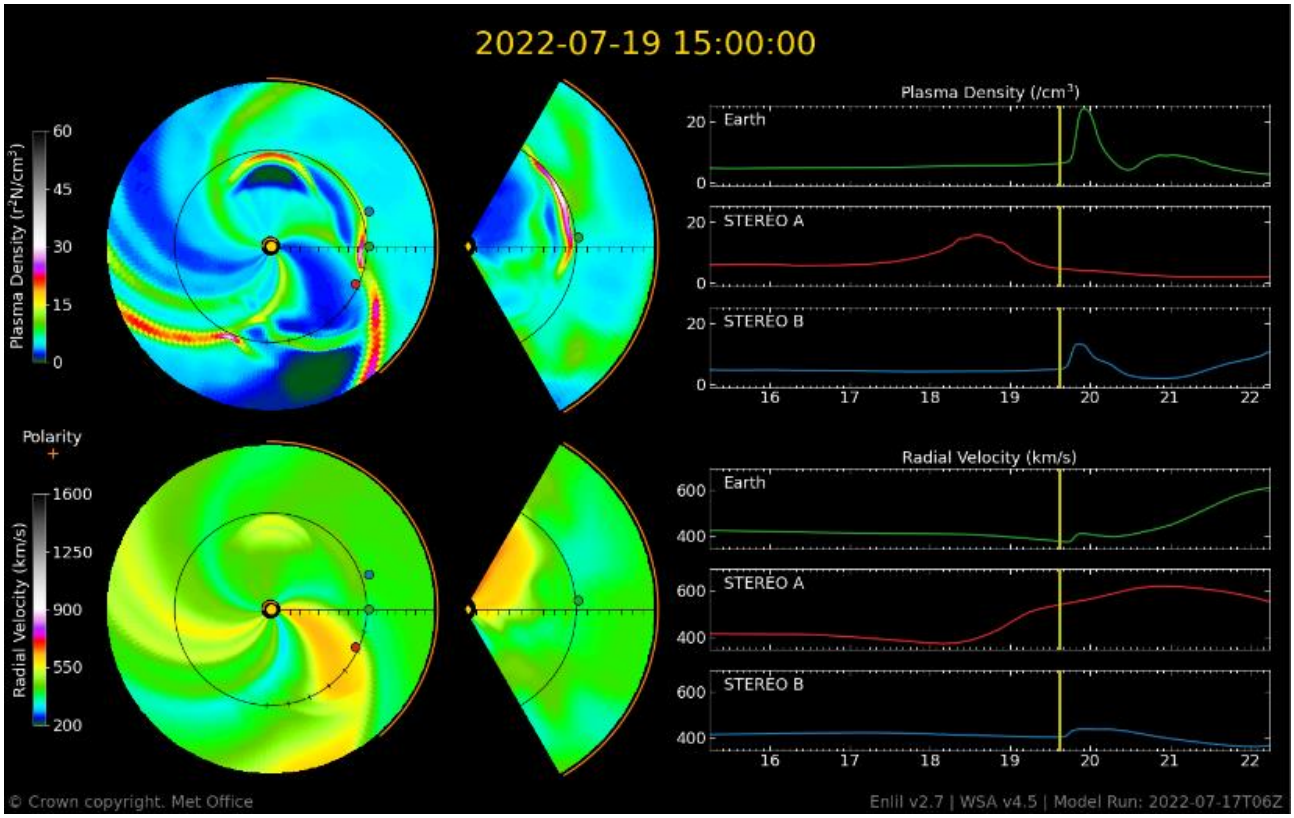
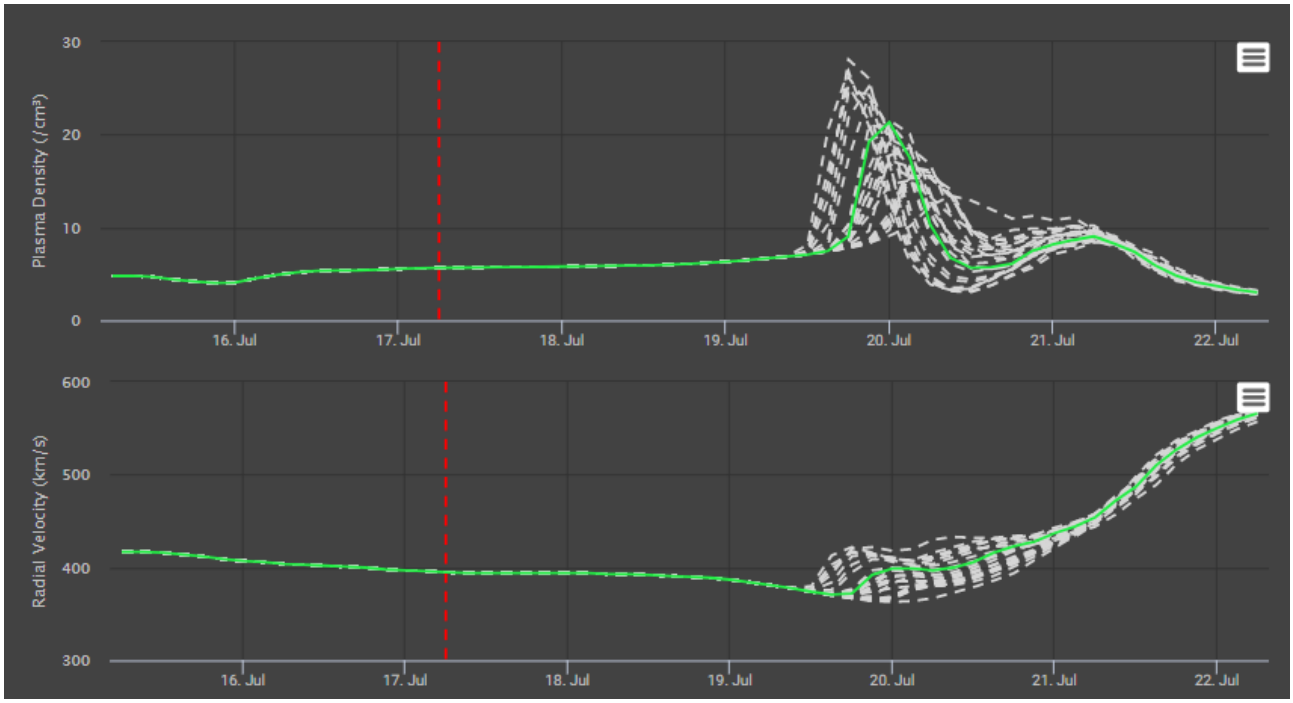
Figure 2: Enlil model and ensemble showing a likely CME arrival later on 19 July or early on 20 July.





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Met Office Space Weather Technical Forecast

Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate in the last 24 hours and further M-class events are Likely to start this period given the number of large, complex sunspot regions. Considering the overall balance of sunspot groups, two regions are due to leave the disc on Days 2 and 3 (18-19 July). This results in a slight decrease in the probability of flaring during the period. Arriving bright flux over the eastern limb may compensate for any loss, however this will be assessed as and when this region arrives over the northeastern solar horizon.

On paper, the most complex region is AR3058 (Dai/Beta-gamma-delta) with a delta region in one of its spots which makes it the most likely region to give M-flares. However, there are a further 4 large regions with sufficient flux to also give M-flares so the risk is distributed across the visible disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	50	40	40
Very Active	R3 to R5 X Class	No	10	10	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at Background levels. Owing to the complexity of the current disc, and in particular several large regions in the west or near centre-disc, there is a daily Slight Chance of S1 or greater occurring. That said, none of the present front-side sunspots have any history of any proton enhancement so far.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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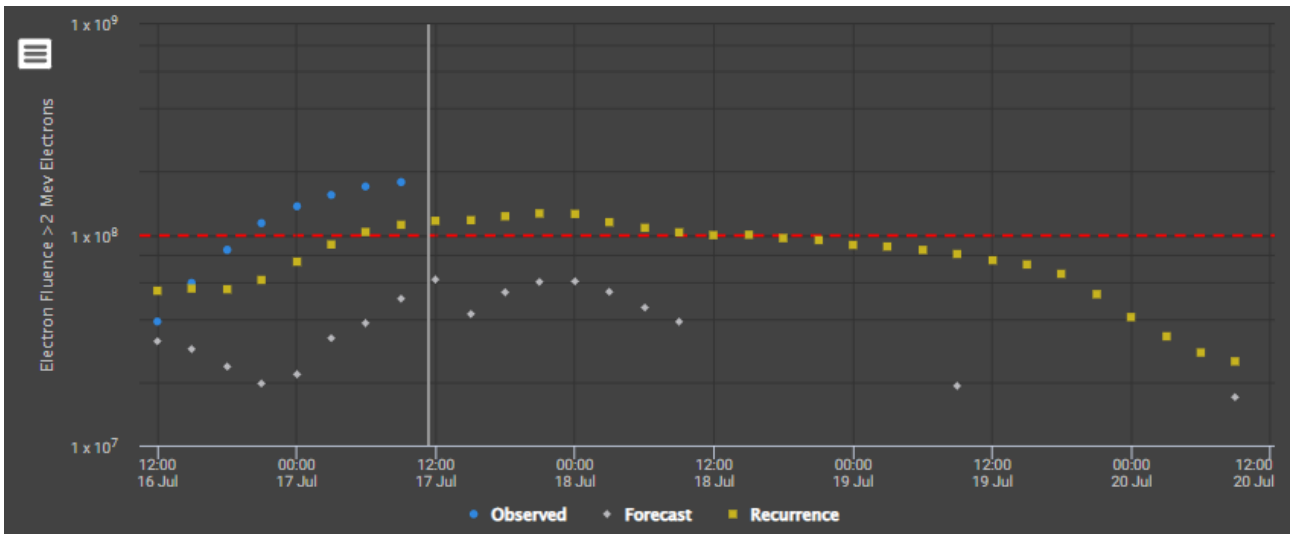
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) has now been at High levels for the last 24 hours, in response to the recent high speed stream. These High levels are expected to persist into Day 3 (19 July), perhaps declining slowly, before an anticipated CME arrival either late on Day 3 or early on Day 4 (20 July) is likely to suppress flux levels.

Fluence is currently above the Active (1e8 integrated pfu) threshold and is expected to stay that way into Day 3. A sharp drop is then likely after the CME arrival. Persistence from the last rotation is offering a reasonable match for current observations, although levels are currently higher than on the previous rotation. REFM appears to be under forecasting fluence levels, and also will not be forecasting the effects of the CME arrival later in the period. As such it isn't currently considered good guidance.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	80	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	2	2	1	1

Figure 3: REFM model is currently under forecasting fluence levels and is not considered good guidance.



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